REPORT

OF THE

NINETEENTH MEETING

OF THE

BRITISH ASSOCIATION

FOR THE

ADVANCEMENT OF SCIENCE;

HELD AT BIRMINGHAM IN SEPTEMBER 1849.

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1850.

Report concerning the Observatory of the British Association at Kew, from Aug. 9, 1848 *to Sept.* 12, 1849. *By* Francis Ronalds, *F.R.S., Honorary Superintendent.*

Notwithstanding the resolution which was adopted at the last meeting of the British Association for discontinuing observations at Kew (a resolution partly founded upon an opinion that the establishment could not be carried on in a manner satisfactory to the Association "on so low a scale of expenditure" as that which had hitherto been found practicable), it was deemed expedient to furnish a fund for defraying the cost of prosecuting experiments then in progress, together with a few necessary expenses of the establishment; and another sum for the reduction and discussion of the series of electric observations which commenced in August 1843 and terminated in August 1848.

The last year's work has therefore been principally devoted to reduction and discussion by Mr. Birt of the electric observations recorded in the five annual volumes preceding this year's volume, and to the due prosecution of the magnetic experiments which were contemplated.

I much regret that it has not been in my power to do more, as regards the discussion of the observations, than confer with Mr. Birt upon the course which was to be adopted*. The other objects became latterly so pressing, and in my humble opinion so important, that it has been quite out of my power to devote the time and attention to the subject which it eminently deserves. The observations have furnished means of computing results, which, combined with the successful prosecution of experiments on a general photographic system of registration, will, I trust, be deemed ample justification of the opinions expressed by the last Kew Committee, presided over by Sir John Herschel, and participated in by the Council, as to the utility of the Kew establishment†.

Mr. Birt's reductions, &c. will appear in a separate Report; and I now proceed to devote a few lines (as usual), first to the state of affairs at Kew, so far as regards the Building, Instruments, &c., and secondly, to an account of the experiments and operations which have been conducted here during the last (Association) year; and a few other matters connected with experimental inquiry.

I. The Building, &c.

The premises having been repaired (outwardly) at the expense of Her Majesty's Government in the previous year, nothing additional has been required to be done in that respect; but I am sorry to add that some parts of the interior are sadly afflicted with dry-rot.

The Quadrant Room has, in consequence of the extraordinary solidity of the foundation, contributed largely to the success of experiments on, and to testing the efficiency of, the self-registering magnetic apparatus, which has been sent by the Superintendent of Magnetic Colonial Observatories, our excellent General Secretary, to Toronto. For the immediate support of that apparatus, two solid stone slabs were attached at the base of the wall temporarily.

The principal Electric Conductor has maintained its original vertical position (with the exception of a slight bending towards the north-east, owing to the prevalence of south-west winds) amid the attacks of six years' tempests; and the insulating power of its only support is improved, rather than otherwise, since its erection by *constant heat* and *age*. A little is

* It was agreed that the Greenwich methods of reducing meteorological observations should (so far as was consistent with the different circumstances) be adopted, with modifications.

† Vide Report of 18th Meeting, p. xvii.

required to be done to prevent the entrance of rain (when violent gusts occur) at the cap.

The Voltaic Electrometers are a little deteriorated (in *appearance* principally).

The Henley Electrometer (*apud* Volta) is certainly in a rather less efficient state than when new. Friction of *pivots* is ever bad in electrometers, and want of employment increases the evil tendency.

The Wind Vane has been nearly destroyed by a fall, in consequence of some bad soldering at its supporting ring.

The following instruments are all in an efficient state for use in observation:—

The Galvanometer.	*Thermometer (standard).*
Discharger.	*Wet-bulb Hygrometer.*
Gold-leaf Electroscope.	*Daniel's Hygrometer.*
Distinguisher.	*Saussure's Hygrometer.*
Three Night registering Electrometers.	*Balance Anemometer.*
Barometers (two).	*Rain and Vapour-Gauge.*

The numerous instruments which have been employed in electric, magnetic, and other experiments and extraordinary observations are not materially, if at all deteriorated. They will be carefully enumerated in a general catalogue of the actual contents of the Kew Observatory arranged under six heads, viz.—

1. Fixtures, furniture, &c. found in the building on the 1st of August 1843.
2. Apparatus supplied by means of a subscription in 1843.
3. Apparatus, and materials for apparatus, purchased out of sums granted annually by the British Association, including a 50*l.* grant from the British Association for experiments.
4. Apparatus presented to the British Association.
5. Books the property of the British Association.
6. Articles which are on loan to the British Association.

II. Experiments, &c.

Soon after the meeting of the British Association at Swansea in August 1848, being very anxious to proceed with the magneto-registering system, I began to make drawings of apparatus on the plan of suspending the declination magnet at right angles (horizontally) with the index arm (all else remaining as before), in order to procure a greater extent of scale with the same amount of light; but reflecting upon some valuable conversation which I had the honour to hold with Dr. Lloyd at the Swansea meeting, and on some suggestions of his afterwards, I made diagrams and calculations for trying his methods of attaching the lens to the magnet, and deflecting it by separate magnets, or by reversion of it, in order to procure a larger range of the instrument itself. I submitted these ideas, &c. to Colonel Sabine, and received obliging and very useful hints from him. I also consulted profitably Mr. Ross the optician.

At the beginning of November I had made arrangements, drawings, &c. for mounting a magnet on Dr. Lloyd's plan, which it was intended should be tried at Woolwich; but the apartment (or observatory) selected not having ultimately been deemed very well-fitted for the purpose, I thought that the Kew building and the Kew establishment could and ought to be appropriated to the attainment of so desirable an end, that it was one exactly calculated for the proper business of the establishment, and Colonel Sabine agreed in these views I believe.

My continued instructive correspondence with Dr. Lloyd on the subject was very profitable, and new arrangements were in consequence contemplated which were applicable to either plan (viz. that of using a *detached* lens as heretofore, or an *attached* lens with deflectors, &c.), for comparing them at Kew; and Mr. Ross received some final instructions as to the work to be executed.

But in the course of Mr. Ross's operations in December, a considerable improvement occurred to me in the management of the light, viz. that of suppressing the condensing lenses at the object-end of the camera, bringing the index much nearer to the lamp, and employing the focus lenses to procure not only a distinct image of the index, but also a brilliant pencil of light (broad enough for *our* purposes) immediately from the flame itself. By these means the time required to produce the desired effect upon the paper was very considerably reduced. Mr. Malone assisted me in these experiments zealously.

Several improvements were also made in the construction and disposition of the time-piece (*vide* Plate II. K), &c.; and at about this time, after many vain attempts, an improvement in the brilliancy of the flame itself was effected by a modification of Count Rumford's "Polyflame Lamp," of three flat wicks, &c., and an especial adaptation of a *high* square copper chimney, &c. (*vide* Plates II. and III. D).

The reason for not instituting the above-mentioned comparison of lenses, was chiefly that of finding the expense of a lens properly adapted to the purpose very considerable. Yet I trust that my anxiety to carry out practically Dr. Lloyd's important suggestions, combined with the occurrence of more favourable circumstances, may not be ultimately unavailing, or that some less costly method than we thought of may be propounded.

In February 1849 Colonel Sabine wished to know the difference of effect (under such circumstances as those in which the Toronto horizontal force magnetometer finds itself in magnetic storms, &c.) between a *slit* in a shield and an *index*. The slit had also occurred to Dr. Lloyd and others, and I resolved upon attempting a strictly practical solution of the question.

But before the experiment had been tried upon *paper*, it struck me that the Daguerreotype process would be far preferable to Talbotype in these cases of rapid and great variations, if not in *every* case, in consequence of the greater sensitiveness, greater capability of retaining the integrity of its normal condition, and greater delicacy (or sharpness) of outline; and the result of the first trials fully confirmed the Colonel's sagacious anticipations of the superiority of the slit, at the same time that the use of silver surfaces became at once indispensable for future operations. On the 23rd of February, two specimens, extremely well defined, were procured, one in twenty seconds, the other in thirty. The first was the stronger (too strong).

The next problem was to *copy* these impressions, for it was deemed too expensive and cumbersome to preserve them; and I spent much time in trials on Mr. Edwards' plan, viz. that of pressing off a part of the mercury upon black paper coated by a solution of isinglass. The sticking, and consequent tearing of the long piece of paper presented great obstacles (amongst others) to the success of these attempts; and I began, with Mr. Malone's obliging assistance, to try whether the Talbotype process could be applied profitably to copy these metalline impressions. A specimen is preserved; but we arrived at the conclusion that the trouble and cost of *time*, &c. in the execution would be too great, and that no copy on paper could ever be so sharp and beautiful as the metalline impression itself.

In the beginning of April I made a little experimental addition to the clock-work, for *imitating* long excursions of a magnet in short intervals, in order to prove the efficacy of the above-mentioned new arrangements relative to light, the slit and the Daguerreotype process in such cases, and adapted it to some horizontal-force apparatus which was intended for the Toronto Observatory; for it was by far too tedious a task to wait for any disturbance approximating in extent to those which occur in Canada. A specimen is preserved of the result, which makes out the case (of success) very well. But we already begin to contemn these *dirty*, although efficient, specimens.

I also began to think about etching the impressions on the plate itself, and received some valuable information on the subject from Mr. Malone, Mr. Hodgson of Winchfield, and other gentlemen; and I found that the *usual* cost of plates was somewhat too high.

Toward the end of May, Daguerreotype apparatus for cleaning, polishing, coating, &c. silvered plates of the length required for our purposes claimed attention, with special regard to saving of time and labour.

About the same time Dr. Lloyd visited the observatory, and suggested the advantage of procuring a *zero line* upon the plate formed by the action of the same source of light which produced the magnetic curve (as I had from the first procured on paper), instead of depending upon the edge of the plate for reading off ordinates. This hint appeared so judicious, that (although presenting difficulties in contrivance and execution, and thus creating delay in the preparations for shipment of the Toronto bifilar apparatus) I thought it right to try experiments, and attained the object. The method will be easily understood presently.

I had now also hit upon an obvious, but very useful addition to all apparatus calculated to measure ordinates of magnetic and other curves from a given abscissa, within certain but extensive distances. This instrument I call the Scale Board (*vide* Plate IV. figs. 2 and 3), and will describe it below.

The last-executed improvements have been upon the instruments used in cleaning and coating the plates, in which Mr. Nicklin has materially assisted; and in carefully etching, or rather engraving and etching, the plate without using (at first) a "ground," for which I am chiefly indebted to Mr. Wood. The plate which has been thus treated is still capable of receiving more impressions in the camera, although the first impression is deeply engraved, and capable of printing any (usual) number of copies. A printed specimen is preserved (*vide* Plate IV. fig. 4).

About the first week in June I experienced great satisfaction in receiving a visit from Colonel Sabine, to inspect the apparatus (which had been experimented upon, improved and tested at our *Kew* Observatory, under the auspices of the British Association) for a horizontal-force magnetograph, to go to the *Toronto* Observatory. It (excepting the stone pillars) was shipped for Montreal, and addressed to Captain Lefroy, Director of the Magnetic Observatory, Toronto, in about the middle of last August, and may be thus described.

(Similar letters refer to similar parts in all the figures, excepting in figs. 2 and 3, Plate IV.)

The figures of Plates I. II. III. and fig. 1 of Plate IV. are drawn to one-eighth of size. Fig. 2 and 3 of Plate IV., and all those of Plate V., are one-fourth of size. Fig. 4 of Plate IV. is of real size.

V (Plate V. figs. 1 and 2, &c.) is the magnet-box, coated (as usual) inside and out with gold paper, and provided with a short tube (v^1), which descends and opens into A.

A is the camera box. a^1 is a solid brass casting, forming in part one of its ends.

B is a fifteen-inch magnet, belonging to a bifilar magnetometer of Dr. Lloyd's construction. b^2 is its stirrup. b^3 a pair of light brass tubes, connected with b^2 by entering a short tube attached to b^2, and permitting a horizontal adjustment (of b^3). The counterbalancing ball at one end is also adjustible (for poising b^3 properly).

b^1 (figs. 1, 3, 4, 5) is the *moveable shield*, composed of very light sheet brass, curved and attached to a little tube, which is clamped by a peculiar nut and screw to the end of b^3. It has a very narrow slit at its lower edge in the centre.

b^4 is the usual copper damper, the upper and lower central portions being formed into curves for the free "*play*" of b^2 and b^3. b^5 b^5 are its supports.

O is a diaphragm plate, whose aperture is about an inch long horizontally and a quarter of an inch wide. It carries

o^1, which is the *fixed shield*, similar in form to b^1, and attached to O by means of a little bolt, washers and nut (o^2). It is capable of adjustments for horizontality, height, &c. At about three-eighths of an inch from its centre is a slit, somewhat larger than the slit in b^1. This shield stands at a distance of about a tenth of an inch from b^1, and at about one-fortieth of an inch higher than b^1.

C is a glass plate admitting light into the camera. It has in front a small brass sliding-shutter.

D (Plates I. and III.) is a lamp constructed on Count Rumford's polyflame principle of three flat wicks raised and lowered by rack-work.

d^1 is its high squared copper chimney, provided with a glass plate about three-quarters of an inch high placed opposite to the best part of the flame (or flames).

E is the mouth, consisting of two angular pieces (as seen in Plate V. figs. 1 and 2), and of two little plates attached to them, forming the lips and aperture e^1, which aperture can be diminished or increased at pleasure after relaxing the little nuts of screws which pass through oblong slits cut through a^1.

A horizontal aperture, of about a quarter of an inch broad, cut through a^1, admits the light which forms the focus at e^1 of the *moveable* slit (in b^1), and a little vertical aperture in a^1 admits the focus of the fixed slit in o^1. The magnetic curve and zero line are produced by these foci respectively.

F is the slider case, for receiving the sliding frame.

f^2 is a perfectly true *ruler* of brass, attached *vertically* to a^1 by means of three screws passing through it, through three thick washers (or little pillars), and through three oblong slits in a^1, &c. It is capable of adjustments for perpendicularity, &c.

f^3 is a roller spring, attached to a^1, and acts upon the slider frame sidewise, pressing it gently against the ruler.

f^5 is a pair of similar springs, acting upon the frame in front, and pressing the glass in the frame against the mouth.

G is the lens tube, containing two groups of Ross's achromatic lenses.

g^1 is apparatus (of sliding plates, &c.) for the support and due centring of G, &c.

g^2 is apparatus of studs, pinion, milled head, key, &c. for moving the rod g^3, which is attached to the stud at g^4, and serves for the adjustments to focus (of G).

H is the sliding frame suspended in F. h^1 are the spring bars for retaining the plates, either metallic or glass, in their proper places. h^2 are friction rollers. h^3 is a hook with a screw in it, which clamps the gut line, entering a hole in the top of H.

I (Plates I. to IV.) is the pulley on the hour-arbour of the time-piece. i^1 the gut line suspending H. i^5 is the counterpoise to H.

K is the time-piece, with its weights, pendulum, &c., and a lever with fork, k^2, for stopping and starting the clock at any given second.

k^1 is the support of K and F.

k^2 are brass tubular braces.

P^N and P^S are stone pillars, whose common centres are in the mean magnetic meridian (about).

P^E and P^W are stone pillars, whose common centres are at right angles to the magnetic meridian (*quasi*).

Q are stone brackets fixed in P^E and P^W for the support of V.

R is a cross slab of stone, resting on P^E and P^W.

r^1 is the cross piece of mahogany (used in Dr. Lloyd's arrangement), secured firmly, with means of adjustments, upon R by bolts and nuts, r^2.

S is the torsion apparatus (of plate, &c.) (Dr. Lloyd's).

s^5 the suspending wire, passing round the grooved wheel.

s^6, on the axis of which b^2 rests "by inverted Y^S."

T the glass tube resting on t^1, which is a fillet contained in t^2, which is a neck or brass tube attached to V.

X is a black marble slab, carrying A, k^1, &c., and supported upon P^N and P^S very firmly, but admitting of a small adjustment (on occasion) about the common axis of the suspending wires, s^5.

Y (Plate IV. fig. 2) is the silvered plate (in the scale board).

y^1 is the magnetic curve produced by the focus of the slit in the moveable shield (b^1).

y^2 is the zero line produced by the focus of the slit in the fixed shield (o^1).

It will be easily perceived that in the arrangement which has now been described no *hygrometric* expansions and contractions can have sensible effect upon the required result, and *I believe* that thermometric variations are equally unappreciable.

The scale board (Plate IV. figs. 2 and 3), for measuring off rapidly and correctly ordinates formed by the magnetic or other curve with the zero line, is thus constructed:—

A is a mahogany board.

a^1, &c. are four screws attaching it to

B, which is another heavier board, and which it is well to clamp upon a sloping desk.

C is a ruler attached to B by a screw at each end, passing easily through an oblong aperture, and allowing a lateral free motion of the ruler upon B. A blank ivory scale is fixed upon C.

c^1 is a milled-headed screw, acting by its shoulder upon a piece which presses C inwards, or against the right-hand edge of Y.

c^2 and c^3 are screws passing through another ruler,

M, &c., fixed immoveably upon B, and acting by their ends upon two little brass sliders which press upon the left-hand edge of Y. This fixed ruler (M) carries a scale of white metal, upon which divisions, representing hours, half-hours, quarters and five minutes, are engraved, a length of one inch representing one hour (for the slider H in the case F is moved by the clock at a rate corresponding with these values). Two spiral springs are contained in B, which cause the two sliders pressing on Y to resume their normal positions when c^2 and c^3 are not employed.

T is the ebony stock of the T square.

t^1 is its blade of white metal, upon which is engraved on one of the fiducial edges divisions representing fiftieths of an inch, and on the other sixtieths, counting from the zero mark, 0, on each series; and it is affixed to T by a milled screw passing through one of the oblong slits at either end, so that either scale may be used, or a blade much more minutely divided might be substituted.

A good double lens, or *pair* of lenses, may be used upon a stand with this apparatus for reading the scales.

The manner of using this instrument is perhaps sufficiently obvious. The zero of the *ordinate scale* (t^1) is adjusted (if necessary) to that right-hand edge and extremity of the zero line (y^2) which is furthest from the *time scale*, M, transversely (after relaxing the screw near T). The ordinate scale is, secondly, applied to the other extremity of y^2; and if the zero point on it should not coincide with y^2, then the screw c^1 is relaxed, and the appropriate left-hand screw (either c^2 or c^3) is slowly screwed up until exact coincidence occurs. Then c^1 is screwed up again.

Particular information, &c. as to the use of the apparatus sent to Toronto was carefully detailed, and some hints relative to the (seemingly) best modes of operating upon the *long* Daguerreotype plates, &c. were set down for the use of Captain Lefroy, &c.

These details are not requisite here. The former *kind* of information has been already published, *i.e.* when my earlier experiments on registration were made known*; and the latter is comprised in great part (although not in sufficient abundance) in several well-known publications.

Proceeding now with the relation of the other circumstances connected with experimental inquiry at Kew, I may add, that at the visit above mentioned of Colonel Sabine we held some conversation on the subject of constructing a *vertical-force magnetograph*, which had previously occupied our attention, when the Colonel relieved me from a difficulty by hinting that an arm might be erected vertically upon the centre of the magnet, to carry the shield with its slit. By this means the injurious proximity of the lamp to the magnet at night will be entirely avoided.

This apparatus is in an advanced state of preparation for Toronto.

My correspondence with the Rev. Alfred Weld, respecting the establishment of a self-registering electric and magnetic observatory at Stonyhurst, after occupying much time (in making plans, drawings, &c.), has not been as yet followed by the erection of a suitable building at that locality.

In August 1848 I received from the Superintendent of the Great Western Railway Electric Telegraph some further and rather curious notices of the deflections of the needles, &c. at Paddington, Slough and Derby. At Paddington, on the 9th of August, at about 1^h 50^m P.M., during a storm, an explosion occurred in the office like that of a gun fired, and the cross wire was fused. The same thing occurred at Slough at the same time.

The most remarkable effects upon these wires are those which are produced by *fogs*; and I apprehend that experiments relative to them would be interesting, and perhaps profitable.

Amongst several distinguished visitors to the observatory in the past year, Don Manuel Rico, Director of the Madrid Observatory, came to converse on the subject of erecting an electrical apparatus like ours at that building, and gave me a rough plan and description of it.

The site appears to be extremely favourable. Experiments and observations in that latitude would form an important link in a geographical series comprising the observations (now probably going on by means of similar apparatus) at Bombay, and others to be instituted in a very high latitude (as Alten, *e.g.*).

* Vide Phil. Trans., Part 1. for 1847.

I trust that other gentlemen, visitors to Kew, have derived some little pleasure, and even profit, from the results of their inquiries here, and that my limited correspondence on electric and other subjects with several gentlemen of scientific eminence has not been wholly profitless to all parties.

I have usually set down under this head a *little* list of proposals for new experiments, or the continuation of old ones; but the number of such-like propositions has accumulated so much faster than the means and time required for their execution, that the catalogue arrives at an almost despairing magnitude. However it shall follow here, because it will at least serve to show that plenty of work could be done at Kew if we had plentiful means.

1. Experiments to determine various points as to the construction of the declination and horizontal-force magnetograph, and particularly Dr. Lloyd's propositions concerning attached lenses.

2. Idem, as to the vertical-force (balance) magnetograph.

3. Idem, as to the completion of a self-corrective system for the barometrograph.

4. Idem, as to the *best* mode of constructing the thermometrograph.

5. Comparison of long and short magnets, and their effects on the registration compared particularly.

6. Experiments in pursuance of some which were commenced here in 1845 on the important subject of "*frequency*" *of atmospheric electricity*; *a subject which has been most unaccountably neglected since the observations of Beccaria* at Turin in about 1750, and one which seems to me to grow in importance with the growth of our chemical and magnetic information.

7. Experiments in pursuance of some which were made at Kew on insulation, and particularly on the insulation of air charged with a known amount of humidity, and at different temperatures, &c., a matter recommended for examination by Coulomb.

8. Experiments in pursuance of the same course, but having especial reference to the measures of atmospheric tensional electricity, as indicated by Henley's and other electrometers, used in attempting to estimate properly *high* tensions.

9. Experiments on apparatus for observing shooting stars.

10. Experiments on the best mode of pursuing observations on terrestrial temperature, as recommended by Professor Forbes.

11. Experiments on kites at known and *constant* elevations, in pursuance of one made at Kew in the year 1847, with a view to their real utility in meteorology.

12. Experiments on the comparative advantages of plate and cylindrical surfaces in reference to their use in self-registering instruments, the former on William Nicholson's construction; and also experiments on a mode of reading off the ordinates on such cylinders.